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FRUCTIFICATION OF MACROCYSTIS

BY

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BY

EDNA JUANITA HOFFMAN.

Macrocystis has a very wide distribution along the western coast of North America. Specimens have been found as far north as Sitka, Alaska, and as far south as Lower California. Setchell and Gardner (1903, p. 270) say, "The long Bladder Kelp is not uncommon on the western coast of North America from somewhere in the neighborhood of Magdalena Bay in Lower California up to the strait of Juan de Fuca. It does not seem to be plentiful in Puget Sound itself, or to the north, and it is doubtful whether it grows beyond Sitka, Alaska. It may have floated into Unalaska, but it seems certain that it does not grow there, at least on the side of the Bering Sea. The species is found floating to the south of Unalaska in the open ocean."

Saunders (1901, p. 431) says that *Macrocystis pyrifera* is not known beyond Sitka, Alaska.

I had the opportunity to examine the dried specimens of Macrocystis which were collected from the western coast of North America, preserved in the Herbarium of the University of California, and can verify the statements made by Setchell and Gardner (1903, p. 270) and by Saunders (1901, p. 431) regarding the distribution of Macrocystis along this coast.

While there is much variation in Macrocystis, the different varieties have been considered as all belonging to the same species and they are usually known under the name of *Macrocystis pyrifera.*

Hooker (1845, p. 156) says that the specimens of Macrocystis occur along the west coast of South America from Cape Horn to the Equator and far westward in the Pacific amongst the Coral Islands. Macrocystis also occurs on the Australian coasts, off New Zealand, St. Paul Islands, the Crozet Islands, and is circumpolar generally in the southern hemisphere.

Professor W. A. Setchell called my attention to the manner of fructification in the few specimens in the Herbarium of the University of California which were in fruiting condition, and my principal study has been upon this problem.

The sori appear on the leaves as darker, thickened patches of irregular shape, varying from one-half to an inch and a half in width and from one-half to three or four inches in length, so far as the specimens examined were concerned.

The appearance of the sorus in cross-section shows the unicellular paraphyses and unilocular zoosporangia characteristic of the Laminariaceae closely pressed together, alternately arranged and covered at the top by a layer of firm colorless jelly.

Earlier writers evidently did not find anything which they recognized as fructification, for Turner (1809, p. 104) says "Fructification at present undiscovered."

C. A. Agardh (1821, p. 46) makes the following statement: "Fructus foliis intumescentibus immersus, constans e tuberculis ubique sparsis, extrinsecus poro minutissimo pertusis & intus includentibus glomerulos seminum numerosissimorum." This description of fruit was undoubtedly taken from a plant no longer included in the genus Macrocystis, viz., the Australian plant now known as *Phyllospora comosa.* Consequently this reference has no bearing on our present problem except to note that this first description of fructification applies to another genus.

The first reference to the fructification of Macrocystis as now understood was made by Mertens in 1829. Mertens (1829, p. 44) makes the following statement, "in einer kammförmigen Verdickung der Blattsubstanz unmittelbar oberhalb der Blase, welche Verdikkung sich durch ihre dunkle Farbe auszeichnet."

In 1831 (p. 172) Dr. Rudolphi also made mention of the fruit of Macrocystis in comparison with that of Ecklonia.

Our first real knowledge of the fruit dates from 1839 when C. A. Agardh published his paper, "Revision der Algengattung Macrocystis" (1839, p. 294), in which he says: "Man bemerkt auf den Wurzelblättern oder understen Stammblättern grosser, dunkler gefärbte, unregelmässig begrenzte Flecken besondere auf der oberen Hälfte der Blattscheibe. Wenn der Inhalt dieser Flecken unter das Mikroskop gebracht wird, so wird man in Wassertropfen zwei verschiedene Körperchen gewahr, welche ich um sie besser zu bezeichnen gleich Sporidien und Perisporidien nennen will."

In Postels and Ruprecht (1840, p. 9) this statement appeared, "Fructificatio: Fila in centro stipitis obscura," but this idea is, of course, erroneous.

Various other references to the fruit of Macrocystis have been made by different authors, such as: "The fructification appears to be produced only on the newly formed submerged leaves." (Hooker: 1845, p. 156.) "Sporangienstände auf den grundständigen Blattkörpern." (Kjellman: 1893, p. 260.) "The fructification is found only on root leaves which never rise to the surface and are destitute of air vessels." (cf. Harvey: 1851, p. 84.)

For reference to fruit found on our own coast we turn to Saunders (1901, pl. LX), who gives a picture which shows the sori of Macrocystis.

Setchell and Gardner (1903, p. 270) say: "The sori are supposed to appear only on the bladderless radical leaves, but on specimens from Peru we have seen sori on leaves near the tip and provided with bladders."

While different authors have given the anatomy and histology of Macrocystis more or less detailed study, the Misses Smith and Whitting (1895, p. 84) published the first paper which has direct bearing on the present problem.

They give the following conclusions as the results of their investigations: (1) That the sori appear only on the newly formed bladderless leaves on the stem just above the holdfast, and (2) that the paraphyses and the zoosporangia appear only in the furrows of the leaf surface.

My principal study was upon specimens gathered at Moss Beach, San Mateo County, California, by Professor Setchell on November 29, 1909, February 20, and April 3, 1910. The material of the last two gatherings was brought to me in fresh condition and was then preserved in a formalin solution. The specimens were found in shallow water, very nearly uncovered at the lowest tide, and while this plant seems to be somewhat different from those growing out in twenty to twenty-five meters of water there does not seem to be any good reason for considering it of a different species.

The Moss Beach plants were attached by a short holdfast, which consisted of a flattened rhizome-like structure bearing numerous hapteres, and from which arose several longer or shorter stems bearing leaves of various sizes and shapes. Some of these stems were as much as eight to ten meters long.

Examination showed that sori were present only on leaves near the base. These basal leaves differed from the upper leaves in one or both of two ways:

(1) Absence of bladders,—or

(2) Possession of a branching blade.

I have represented in plate 20, fig. 1, sori on leaves with and without bladders. In some of the leaves, division is unequal and unilateral and still in the very young stage like that of the terminal leaf from which the longer frond arises, and in the third leaf which bears a bladder at the base advanced, equal, dichotomous division has taken place. In no case did I find sori on leaves bearing single blades and with a bladder at the base.

In plate 20, fig. 2, I have represented the terminal leaves in the same condition as in fig. 1, and have also shown a bladderless equal dichotomous division of leaves bearing sori. The other leaves are identical with those in fig. 1.

I had the opportunity to examine several dried specimens of *Macrocystis pyrifera* which were gathered in Peru by D. G. Fairchild in 1899, which are preserved in the Herbarium at the University of California, and found that sori are present on the single blades of bladder-bearing leaves. It is not possible to decide how far from the holdfast the specimen preserved has

been taken, but it is evident that the leaves which bear the sori are not newly formed basal ones and they must be at least three removes from the holdfast.

The other conclusion of the Misses Smith and Whitting's paper was that the reproductive bodies appeared only in the furrows of the leaves.

Cross-sections from the *Macrocystis pyrifera* gathered at Moss Beach showed that the paraphyses and the zoosporangia were arranged in unbroken layers which extend the entire breadth of the sorus and appear on both sides of the leaf. I also examined the sori of some dried specimens which were preserved in the herbarium (University of California) and found the fruit in regular layers in *Macrocystis pyrifera* from San Pedro, California, and in the same species from Peru the paraphyses and the zoosporangia were also arranged in continuous layers. No such conditions as a furrow in the leaf was found to exist. Some old wrinkled leaves suggested that possibility, but a section showed that no reproductive bodies were present.

Another specimen from Santa Cruz Beach, California, showed the same regularity of arrangement of the reproductive bodies.

The facts gained from this investigation have been quite different from those published by the Misses Smith and Whitting, for our specimens show that the sorus is not confined to the newly formed bladderless leaves alone and also that the reproductive bodies appear in continuous instead of disconnected layers only in the furrows of the leaves. The very different results obtained suggest that Misses Smith and Whitting may have worked with an entirely different species, but since they do not mention the localities from which their materials were gathered it is impossible to decide that question.

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EXPLANATION OF PLATE 20.

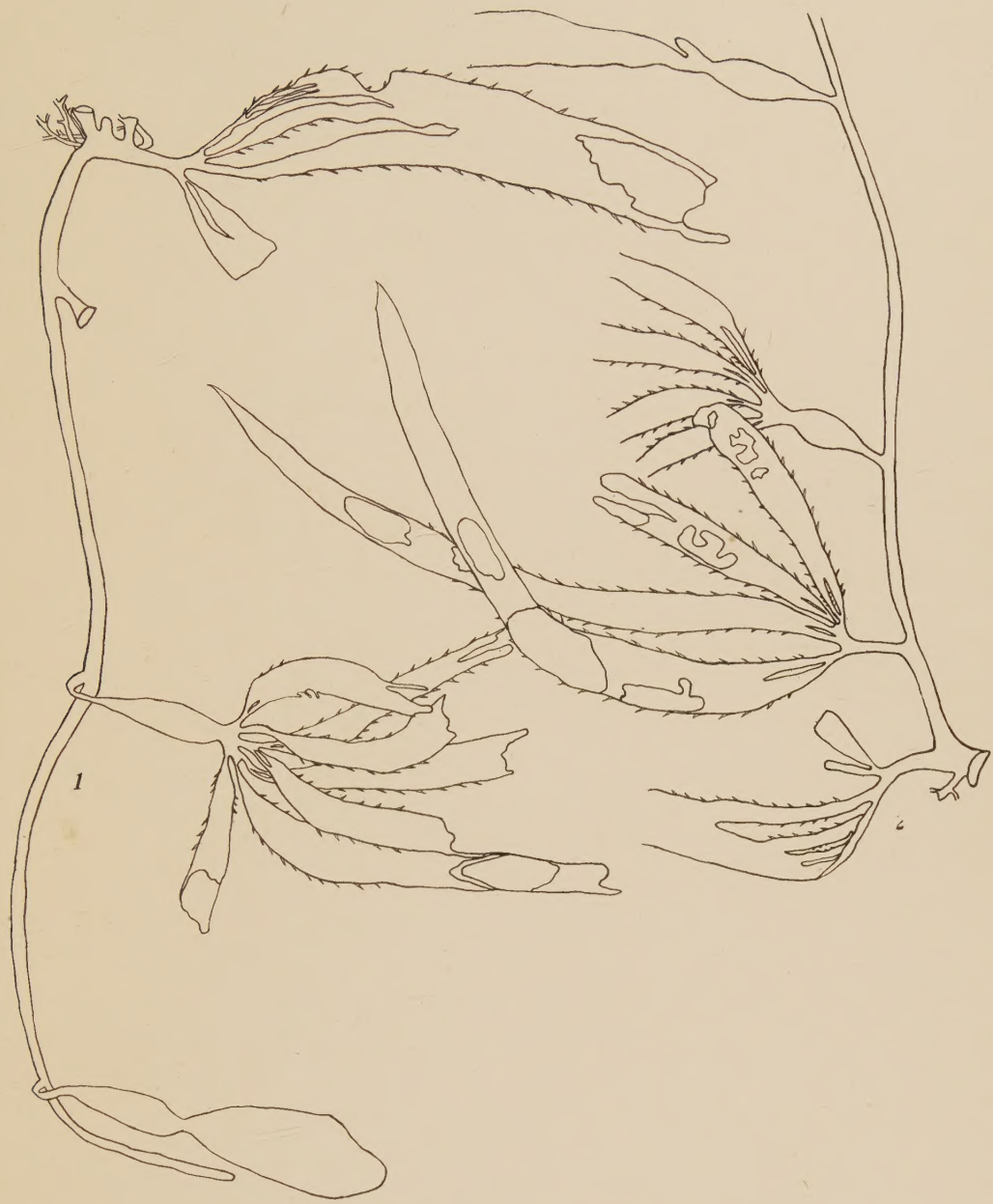
Macrocystis pyrifera (Turner). Agardh.

Tracings of specimens from Moss Beach, San Mateo County, California.

1. Basal portion of plant showing a portion of the holdfast, a basal branch with several leaves in process of formation but with a sorus, and the main stem with the basal leaf removed. A bladder bearing multilaminate leaf with sori, and a simple bladder bearing leaf without a sorus.

2. Similar portion of another plant showing the second branch from the base as having no bladders, but several blades in process of separation, some of them with sori.

Reduced to ⅓ original diameter.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